Bonneville Power Administration
Fish and Wildlife Program FY99 Proposal

Section 1. General administrative information

Life-Cycle Model Development And Application To System Planning

Bonneville project number, if an ongoing project 9203200

Business name of agency, institution or organization requesting funding
USDA Forest Service, Rocky Mountain Research Station

Business acronym (if appropriate) USFS

Proposal contact person or principal investigator:

Name	Danny C. Lee
Mailing Address	316 E. Myrtle Street
City, ST Zip	Boise, ID 83702
Phone	(208) 373-4386
Fax	(208) 373-4391
Email address	dlee/rmrs_boise@fs.fed.us

Subcontractors.

Organization	Mailing Address	City, ST Zip	Contact Name

NPPC Program Measure Number(s) which this project addresses.
BPA SUPP

NMFS Biological Opinion Number(s) which this project addresses.
ND-Program Support

Other planning document references.
Portions of the research carried out under this project has been used within the Interior Columbia Basin Ecosystem Management Project (ICBEMP), or alternatively, has built upon data bases and infromation gathered by the ICBEMP.

Subbasin.

Short description.
Improve decision-support tools for (1) assessing overall program effectiveness, and more specifically (2) assessing the impacts of land-use activities on resident and anadromous salmonids.

Section 2. Key words

Mark	Programmatic Categories	Mark	Activities	Mark	Project Types
X	Anadromous fish		Construction		Watershed
	Resident fish		O & M		Biodiversity/genetics
	Wildlife		Production		Population dynamics
	Oceans/estuaries	X	Research	X	Ecosystems
	Climate		Monitoring/eval.		Flow/survival
	Other		Resource mgmt		Fish disease
			Planning/admin.		Supplementation
			Enforcement		Wildlife habitat en-
			Acquisitions		hancement/restoration

Other keywords.
decision-support, modeling, experimental design, watershed assessment, PATH

Section 3. Relationships to other Bonneville projects

Project #	Project title/description	Nature of relationship
9600600	PATH - Facilitation, Tech Assistance, and Peer Review	Analyses contribute directly to PATH
9202603	Idaho Model Watershed:	Technical assistance

Section 4. Objectives, tasks and schedules

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Enhance the Bayesian Viability Assessmen Model (BayVAM)	a	Increase the fexibility of the model.
1		b	Improve methods for selecting

			model forms and estimating parameters.
1		c	Improve the user-friendliness of the model.
1		d	Technical transfer
2	Improve Monitoring of Instream Habitat Conditions and Watershed Assessment	a	Validation of exisisting monitoring protocols
2		b	Development of optimal sampling designs
2		c	Develop protocols for information updating

Objective schedules and costs

Objective #	Start Date mm/yyyy	End Date mm/yyyy	Cost %
1	1/1998	9/2000	40.00%
2	10/1997	9/2001	60.00%
			TOTAL 100.00%

Schedule constraints.

Completion date.
FY 2001

Section 5. Budget

FY99 budget by line item

Item	Note	FY99
Personnel	2 GS-11 Scientists for 48 pay periods	$75,650
Fringe benefits		$18,000
Supplies, materials, non-expendable property		
Operations & maintenance		
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		
PIT tags	# of tags:	
Travel		$2,400

Indirect costs	22%	$21,131
Subcontracts		
Other		
TOTAL		$117,181

Outyear costs

Outyear costs	**FY2000**	**FY01**	**FY02**	**FY03**
Total budget	$120,000	$72,000		
O&M as % of total	0.00%	0.00%		

Section 6. Abstract

Proposed new work for FY 1999 builds upon recent progress in five arenas: 1) the recently completed ICBEMP scientific assessment, 2) the ongoing PATH process, 3) development of a Bayesian viability assessment model (BayVAM), 4) the NPPC's model watershed process, and 5) recent advances in monitoring techniques and methods of analysis. Collectively, these efforts significantly improve and expand the information and analytical tools available to support ecosystem management in the Columbia River Basin. Further work is needed to fully realized the benefits of these efforts. In particular, a concerted research program is needed to integrate some of the disparate parts of these efforts into a more seamless decision-support system. To assist in this effort, we propose research directed at enhancing the BayVAM model, and improving protocols for watershed assessment and monitoring of instream habitat conditions. Planned enhancements in the BayVAM model include increased flexibility of the model to accommodate alternative model forms, improved parameter estimation procedures, and increased user-friendliness. Efforts to improve watershed assessment and monitoring will focus on validating existing monitoring protocols, developing optimal sampling designs, and developing protocols for information updating. This continuing research effort has been jointly funded by the Forest Service, NMFS, EPA, and BPA since 1992.

Section 7. Project description

a. Technical and/or scientific background.

This project is part of a larger effort that has been funded by the USDA Forest Service, Bonneville Power Administration (BPA), the National Marine Fisheries Service (NMFS), and the Environmental Protection Agency (EPA). It began as an effort to improve the Stochastic Life-cycle Model (SLCM, Lee and Hyman 1992), provide parameter estimates for Snake River stocks, and investigate means for cataloging habitat inventory information using a Geographic Information System (GIS). The effort has since grown to a more fully integrated look at how spatially explicit habitat and landscape information can be incorporated into population viability assessments, and how one can

monitor and evaluate the effects of land-use activities on instream habitats and fish populations. Recently, this effort contributed to methods used within the Interior Columbia Basin Ecosystem Management Project (ICBEMP) that is directed by the Forest Service and Bureau of Land Management. The principal investigators also participate in the interagency committee that is engaged in the PATH process, providing data and analyses specific to spawning and rearing habitat influences on anadromous fish production.

Decision-support tools developed under this project have played important roles in Columbia River Basin assessment and planning activities. The improved SLCM model was one of the principal models used by BPA and NMFS in assessing the possible impacts of proposed activities on threatened and endangered chinook stocks. National Forests throughout the Northwest, the ICBEMP (Lee et al. 1997, McKinney et al. 1996), and the Model Watershed process are using GIS techniques pioneered by Forest Service researchers (Overton et al. 1995, Radko 1997). Recent work has focused on development of a set of models, called the Bayesian Viability Assessment Models (BayVAM) that can be used to assess habitat condition in terms of suitability for both resident and anadromous salmonids. These models are unique in that they allow expert knowledge to be combined with quantitative and qualitative information in a rigorous, repeatable, and defensible manner (Lee and Rieman 1997). They currently are being tested in watersheds from California to Montana. The resident fish version was used in an extensive analysis of westslope cutthroat trout in the upper Missouri Basin (Shepard et al. 1997). Following the testing phase and subsequent modification, the BayVAM modules will be incorporated into the Federal guide for watershed analysis.

The scientific assessment completed as part of the ICBEMP (Lee et al. 1997) motivated the development of a new suite of analytical tools that could be used to link landscape features to fish population status and distribution. The ICBEMP also assembled extensive databases on anthropogenic features and physiographic, vegetative, and aquatic conditions. These data, and the tools to analyze them, create a rich field for scientific inquiry. To date, research has focused on parametric and non-parametric models that treat fish population status at the watershed level (Lee et al. 1997) or stock productivity (Thompson and Parnell in prep.) as response variables, and use landscape descriptors as predictor variables. Haas et al. (in prep) have compared various statistical models for this purpose, including logistic regression, classification trees, k-nearest-neighbor classifiers, and neural networks. This works suggests that some non-parametric methods such as neural networks can provide highly accurate models in terms of predictive success, at the cost of interpretability and ease of implementation. A software program, CATDAT, has been developed for general distribution that allows analysis of similar data sets using the techniques examined by Hass et al.

Much of the proposed work in the project will focus on improving protocols for monitoring and evaluating land-use impacts on instream habitat conditions. Recent directives such as PACFISH have emphasized the use of quantifiable standards based on measurement of physical channel features such as pool frequency and sediment levels. The scientific community does not universally accept the use of such standards. Several authors (e.g., Poole et al. 1997, Lee et al. 1997) have pointed to shortcomings in using threshold standards for channel features due to the inherent variability in such features

and the technical difficulties in measuring them accurately. Suitable substitutes for threshold standards that are scientifically valid remains an elusive research target.

b. Proposal objectives.

This project has two major objectives.

(1) Improve the flexibility, parameterization, and user-friendliness of the BayVAM model.—The BayVAM model was designed to provide a probabilistic assessment of population viability given reasoned estimates of key population parameters based on professional judgment. The Missouri Basin application of the BayVAM model (Shepard et al. in press) identified some needed enhancements in the model. One apparent problem was that biologists had a difficult time judging habitat conditions and then translating these conditions into population parameters consistently. The end result was more uncertainty in the parameter estimates than might have resulted from a less subjective approach. A second problem was that the biologists that provided inputs to the BayVAM model did not actually run the model, but instead passed the inputs to an analyst who ran the model and compiled the results. This process lacked the benefit of an immediate feedback mechanism that might have allowed the biologists to update their estimates based on the cumulative effect. For example, the model-derived estimates of population equilibrium size and resiliency generally were much lower than the biologist's estimates of these properties when asked directly. An ability to interact with the model might have produced more consistency. The tasks identified below are aimed to address these problems.

(2) Develop tools and techniques for improved monitoring of instream habitat conditions and watershed assessment.—One of the more enduring and perplexing problems facing land management agencies is how to accurately and succinctly characterize instream habitat conditions in a manner that allows early detection of deleterious effects of landuse practices, or provides measurable standards for watershed restoration and recovery. Despite two decades of research, major sampling and analysis issues remain unresolved. Recent statistical advances in sampling theory and multivariate statistics offer hope of addressing some of the more stubborn problems. Additionally, there has been a recent convergence among multiple agencies to adopt habit-unit based sampling schemes that provide a stratified sampling design for measuring stream characteristics. The adoption of common sampling protocols combined with electronic storage of monitoring data has allowed compilation of massive data sets that allow rigorous introspection of these monitoring protocols. For example, the ICBEMP compiled a data set based on more than 600,000 habitat units sampled over 17,000 km of streams in the Columbia River Basin (see McKinney et al. 1996). We propose the tasks below, which build on recent statistical advances and the availability of existing data.

c. Rationale and significance to Regional Programs.

Effective management of freshwater habitats that support spawning and rearing of anadromous fishes, and all life stages of resident fishes, is critical to the success of the Fish and Wildlife Program. Throughout much of the basin, managing freshwater habitats is synonymous with managing terrestrial land uses to minimize adverse impacts on the aquatic environment. Land managers can be effective only if they are informed as to the extent of their impacts. This requires accurate and efficient monitoring of land-use effects on the physical features of the aquatic environment, and a credible assessment of the suitability of the aquatic environment to support targeted species. The research program described here is designed to serve these two information needs.

This is a large and complex research program that is a major focus of the Forestry Sciences Laboratory in Boise. As such, the Forest Service is the primary source of funding for the program, covering most of the personnel, facility, and equipment expenses. Auxiliary funding is obtained from BPA (this proposal), NMFS, and the EPA to help defray costs related to temporary personnel, travel, and specialized equipment. While the research program would likely continue even in the absence of this auxiliary funding, the scope and intensity of the effort and the rate at which it would be completed certainly would be diminished. Furthermore, outside funding helps ensure that research results are more efficiently and expeditiously shared with the wider research and management community through means such as the PATH (Project 9600600) and model watershed (e.g., Project 9202603) processes.

The program has several different facets, and it is not feasible to describe each element in detail here. Each of the tasks described in 7(e) below will be completed in accordance with Forest Service research guidelines, which require formal planning and peer review prior to implementation and publication of results. Much of what is proposed is a combination of research and development. That is, the research often accompanies the development of new tools and techniques that ultimately must be used by others. This imposes an iterative process of prototyping, evaluating, and refining products, which makes it difficult to accurately predict timelines for deliverables.

d. Project history

For fiscal years 1993-1997, total project funding was approximately $212,000. As of January, 1998, these funds have not been fully expended. The remaining balance of these funds will be used to support two post-doctoral research biologists through fiscal year 1998. An additional $68,000 was approved for the project in the draft FY98 budget. If this current proposal is funded in its entireity for FY99 (i.e., for $117,181), then the FY98 funds likely will not be requested from BPA, and will be freed to support other projects.

In addition to annual reports for 1992 and 1993, the project has contributed to the following: a published report on a conceptual framework for modeling and planning within the Columbia River Basin (Lee and Grant 1996); published documentation of the SLCM (Lee and Hyman 1992); several technical notes on the use of GIS in assessing fisheries habitat (Overton et al. 1995, Radko 1997), a paired watershed study within the Little Salmon River drainage (Overton et al. 1993), and the scientific assessment of the ICBEMP (Lee et al. 1997). Papers in press highlight an example Bayesian belief network

for assessing land-use threats to bull trout (Lee 1998), describe the BayVAM models (Lee and Rieman 1997), and discuss an important application (Shepard et al. 1997).

e. Methods.

To improve the BayVAM model, we propose three principal tasks:

A. *Increase the flexibility of the model.* As currently configured, the BayVAM models (both anadromous and resident versions) are limited to a single functional form, e.g., one cannot change the shape of the basic underlying relationship between juvenile density and survival. This may be unnecessarily limiting where available data might suggest an alternative form, or where one simply would like to investigate the implications of alternative model forms. Our intent is to incorporate alternative model forms for juvenile survial (e.g., Ricker vs. Beverton-Holt) into the BayVAM model, and incorporate a broad range of parameter values for each model form. AN additional option is to construct a BayVAM version that uses the prospective model developed in the PATH process as the underlying viabililty model. (see Project 9600600 references; pertinent PATH documents are currently in internal draft form only)

B. *Improve methods for selecting model forms and estimating parameters.* In many cases where a viability analysis is desired, there is little or no empirical data available from the population in question. In such cases, it is imperative that a rigorous means of estimating parameters based on ancillary information on habitat conditions is provided. Much of our previous effort to develop parameter estimation protocols has relied on published studies. For anadromous species, ongoing PATH analyses that utilize ICBEMP data provide additional information that could be used to develop parameter estimation protocols. Similar information might be identified for resident species through an intensive literature search and regional survey of ongoing research. Where empirical data are available, statistical methods exist for choosing among alternative models and selecting parameters that are consistent with the data. Our intent under this task would be to develop a protocol for model selection and parameter estimation that combines statistical techniques for use when data are available and clear direction for estimating parameters based on ancillary information where data are lacking. A rich base of online information would support the improved direction and references that would help promote consistency.

C. *Improve the user-friendliness of the model.* The BayVAM model is currently distributed as a computer spreadsheet that runs under a variety of commercial spreadsheet programs. While this format is perfectly adequate for many users, the spreadsheet format may become unwieldy as the model becomes more complicated, and as increased amounts of online information is provided to model users. In addition, the spreadsheet format does not provide the full flexibility of a Bayesian belief network. Microsoft Corporation has recently developed a software program for development of Bayesian belief networks. At present, Microsoft offers this software

free of charge to non-profit research organizations. We intend to explore to potential of using the Microsoft software for BayVAM applications, as well as other software alternatives. The next generation of BayVAM models would then be developed under a new software platform chosen after considering cost, portability, and ease of use.

Three tasks are proposed related to improving tools and techniques for watershed assessment and monitoring instream habitat condition:

A. *Validation of existing monitoring protocols*. The purpose of this task is to determine if monitoring protocols in use by the Forest Service and other agencies are in fact adequate to answer the types of questions for which there were intended. Recently published studies suggest that they are not (Lee et al 1997, Poole et al. 1997). We intend to examine existing protocols and datasets in light of the geomorphic and biological logic supporting each protocol, and the accuracy, precision, and repeatability of the measurements.

B. *Development of optimal sampling designs*. Instream monitoring and watershed assessment can be a labor intensive, expensive operation. Prudent management requires an efficient monitoring design the makes optimal use of sampling efforts. In order to design an efficient monitoring scheme, one has to clearly define the objectives on the study and be cognizant of the inherent variability in the target landscape and in the measurement tools used in the study. Recent advances in sampling (Schreuder et al. 1993, Scott 1984, Thompson 1992) can be used to considerably improve sampling efficiency. In addition, if information needs can be cast in a decision analysis framework, then "value of information" becomes a useful criterion for designing monitoring protocols. In a decision analysis framework, monitoring focuses on the things that influence decisions and ultimately affect overall utility, where utility is measure of the "good" of the outcome. In a similar fashion, decision analysis can be portrayed as a risk assessment, where the intent is to minimize risks. We intend to explore optimal sampling designs through a series of case studies, perhaps working with the Boise and Payette National Forests and EPA in the South Fork Salmon River, and with participants in the NPPC's model watershed process.

C. *Information updating*. One goal of monitoring through time is to continually evaluate resource status in order to detect changes or trends early enough to adjust management, if appropriate. This creates the need for a systematic means of updating information bases to provide current estimates of key system parameters. Gathering lots of information in lots of places in order to maintain a comprehensive inventory can be very expensive. More efficient approaches may be possible through the use of sophisticated, adaptive sampling techniques (Thompson and Seber 1996) and advanced methods for parametric updating. The empirical Bayesian approach (Ver Hoef 1996) can be used to readily combine sequential analyses, and there may be other approaches with similar properties. We intend to explore the empirical Bayesian approach and similar methods as a means of information updating in stream monitoring.

f. Facilities and equipment.

All analyses will be conducted at the Forestry Sciences Laboratory in Boise, ID, using modern, IBM-compatible personal computers and IBM Unix workstations.

g. References.

Lee, D. C. 1998. Assessing land-use impacts on bull trout using Bayesian belief networks. In S. Ferson, editor. Quantitative methods in conservation biology. Springer-Verlag, New York (in press).

Lee, D. C., and J. B. Hyman. 1992. The Stochastic Life-Cycle Model: Simulating the population dynamics of anadromous salmonids. Research Paper INT-459. USDA Forest Service, Intermountain Research Station, Ogden, UT. 30 p.

Lee, D. C. , and W. E. Grant. 1995. A hierarchical approach to fisheries planning and modeling in the Columbia River Basin. Environmental Management 19(1):17-25.

Lee, D. C., and B. E. Rieman. 1997. Population viability assessment of salmonids using probabilistic networks. North American Journal of Fisheries Management (in press).

Lee, D. C., J. R. Sedell, B. E. Rieman, R. F. Thurow, J. E. Williams, and others. 1997. Broadscale assessment of aquatic species and habitats. In Quigley, Thomas M. and Arbelbide, S.J; tech. eds. An assessment of ecosystem components in the interior Columbia Basin and portions of the Klamath and Great Basins. Gen. Tech Rpt. PNW-GTR-405. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

McKinney, S. P., J. O'Conner, C. K. Overton, K. MacDonald, K. Tu, and S. Whitwell. 1996. A characterization of inventoried streams in the Columbia River Basin. U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. Aqua-Talk, R-6 Fish Habitat Relationship Technical Bulletin, Number 11. 119 p.

Overton, C. K., J. D. McIntyre, R. Armstrong, S. L. Whitwell, and K. A. Duncan. 1995. User's guide to fish habitat: descriptions that represent natural conditions in the Salmon River Basin, Idaho. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, General Technical Report INT-GTR-322, Ogden, UT. 142 p.

Overton, C. K., M. A. Radko, and R. L. Nelson. 1993. Fish habitat conditions: using the Northern/Intermountain Regions' inventory procedures for detecting differences on two differently managed watersheds. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, General Technical Report INT-300, Ogden, UT. 14 p.

Poole, G. C., C. A. Frissell, and S. C. Ralph. 1997. In-stream habitat unit classification: inadequacies for monitoring and some consequences for management. Journal of the American Water Resources Association 33(4):879-896.

Radko, M. A. 1997. Spatially linking basinwide stream inventories to arcs representing streams in a geographic information system. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, General Technical Report INT-GTR-345, Ogden, UT. 22 p.

Schreuder, H. T., T. G. Gregoire, and G. B. Wood 1993. Sampling methods for multiresource forest inventoy. John Wiley & Sons, Inc, New York, NY. 446 p.

Scott, C. T. 1984. A new look at sampling with partial replacement. Forest Science 30(1):157-166.

Shepard, B., L. Ulmer, B. Sanborn, and D. Lee. (1997) Status and risk of extinction for westslope cutthroat trout in the upper Missouri River basin, Montana. North American Journal of Fisheries Management (in press).

Thompson, S. K. 1992. Sampling. John Wiley & Sons, Inc., New York, NY. 343 p.

Thompson, S. K., and G. A. F. Seber. 1996. Adaptive Sampling. John Wiley & Sons, Inc., New York, NY. 265 p.

Ver Hoef, J. M. 1996. Parametric empirical Bayes methods for ecological applications. Ecological Applications 6(4):1047-1055.

Section 8. Relationships to other projects

This is repeated from section 7(c):

This is a large and complex research program that is a major focus of the Forestry Sciences Laboratory in Boise. As such, the Forest Service is the primary source of funding for the program, covering most of the personnel, facility, and equipment expenses. Auxiliary funding is obtained from BPA (this proposal), NMFS, and the EPA to help defray costs related to temporary personnel, travel, and specialized equipment. While the research program would likely continue even in the absence of this auxiliary funding, the scope and intensity of the effort and the rate at which it would be completed certainly would be diminished. Furthermore, outside funding helps ensure that research results are more efficiently and expeditiously shared with the wider research and management community through means such as the PATH (Project 9600600) and model watershed (e.g., Project 9202603) processes.

Section 9. Key personnel

Principal Investigator: Danny C. Lee

Dr. Lee is a Research Biologist at the Rocky Mountain Research Station (formerly Intermountain Research Station) located in Boise, ID, where he has been employed since 1991. Previously, he was a fellow at Resources for the Future in Washington, DC (1986-1991). He holds degrees from the University of Tennessee (B.A.-1981, M.S.-1983), Louisiana State University (M. Applied Statistics-1984), and Texas A&M University (Ph.D.-1989). His formal training is in ecology, statistics, and wildlife and fisheries sciences. His expertise is in population dynamics, systems analysis, statistics, and ecological modeling.

Dr. Lee has led this project since its inception in 1992, and continues to be the lead architect and technical expert. He also supervises two post-doctoral researchers and two fish biologists that work on the project. He is the primary author of the SLCM and BayVAM population simulation models, and has been an active participant of PATH and other interagency committees preceding PATH. Recently, he was the co-leader of the aquatics team working on the ICBEMP, and a principal analyst in the project. Recent publications are listed in section 7(g) above.

Other key personnel:

James T. Peterson, Research Biologist, USFS Rocky Mountain Research Station

EDUCATION

University of Missouri at Columbia

Doctor of Philosophy, Fisheries December 1996

University of Illinois at Urbana- Champaign

Master of Science, Biology May 1990

Bachelor of Science, Ecology, Ethology, and Evolution May 1986

PROFESSIONAL EXPERIENCE

Collected fish using various methods of electrofishing, seining, trapping, and rotenone. Developed and evaluated the efficiency of several lotic fish collection methods. Measured and evaluated microhabitat use by various species. Synthesized and analyzed landscape data with Arc/Info. Computer programmed in Basic, Fortran, Pascal and C. Developed automated fish data entry system and large database systems. Assisted in the development of categorical data analysis software and provided technical support. Analyzed fish community and physical habitat data with various parametric, nonparametric, univariate, and multivariate statistical methods. Developed macroinvertebrate and fish-based water quality monitoring protocols. Developed a stream habitat classification system. Wrote proposals for research funding and final reports. Published in refereed journals. Certified electrofisher and diver.

EMPLOYMENT

USDA Forest Service, Rocky Mountain Research Station

Postdoctoral Research biologist (1997-present)

The evaluation of Forest Service Regions 1 and 4 fish and habitat monitoring and inventory protocol

The investigation the influence of landscape characteristics on fish distribution and community structure and different spatial scales

The investigation of the effects of fish sampling bias on the analysis of fish sampling data

The creation of the categorical data analysis software users manual and technical support

University of Missouri at Columbia

Postdoctoral Research Assistant (1996)

Prairie Cluster National Park Long-Term Ecological Monitoring Project

PhD. Research Assistant (1991- 1996)

Global Climate Change Project

Missouri Biocriteria Project

SELECTED WORKS

Peterson, J. T., and C. F. Rabeni. 1995. Optimizing sampling effort for sampling warmwater stream fish communities. North American Journal of Fisheries Management 15: 528-541.

Peterson, J. T. 1996. Suggested biomonitoring protocol and status of stream quality at six Great Plains National Parks. Final Report. Missouri Cooperative Fish and Wildlife Research Unit, University of Missouri, Columbia.

Peterson, J. T. 1996. Long-term ecological monitoring protocol for Prairie Cluster National Park streams. Missouri Cooperative Fish and Wildlife Research Unit, University of Missouri, Columbia.

Rabeni, C. F. R. Sarver, N. Wang and J.T. Peterson. 1997. Development of regionally based aquatic biocriteria for Missouri. Final report to the Missouri Department of Natural Resources. Jefferson City, Missouri.

Peterson, J.T. and T.J. Kwak. In review. Modelling the population effects of land use and climate change on smallmouth bass.

William L. Thompson

EDUCATION

Ph.D., Biological Sciences, Montana State University, 1993 (Minor: Statistics)

M.S., Fish and Wildlife Sciences, Pennsylvania State University, 1987

B.S., Wildlife and Fisheries Biology, University of Vermont, 1984

CURRENT EMPLOYMENT

8/97 to Present; Postdoctoral Research Biologist/Quantitative Ecologist, USDA Forest Service, Rocky Mountain Research Station, Boise, ID. Using AIC model selection techniques to model stock-recruitment and habitat data for anadromous salmonid populations in the Interior Columbia River Basin, revising a user's manual for a software program that uses Bayesian Belief Networks to compute population viability analyses for resident salmonid populations, and assisting in development of a SAS simulation program to evaluate relative bias and efficiency of various plot selection techniques in estimating population trends.

MOST RECENT WORK EXPERIENCE

7/96-6/97; Postdoctoral Research Fellow, Dept. of Fishery and Wildlife Biology, CO St. Univ., Fort Collins, CO.
1/95-6/96; Postdoctoral Research Fellow, Dept. of Fishery and Wildlife Biology, CO St. Univ., Fort Collins, CO.
2/94-11/94; Environmental Research Consultant (Co-founder), M.T. Inc., Bozeman, MT.
10/93-11/93; Statistical Consultant, Lostwood National Wildlife Refuge, Kenmare, ND.
10/93-11/93; Fisheries Technician, MT Cooperative Fisheries Research Unit, MT State Univ., Bozeman, MT.
7/93-8/93; Environmental Consultant (subcontracted), Morrison-Maierle Environmental, Bozeman, MT.

EXPERTISE

My expertise is in designing survey methods for sampling biological populations, developing and evaluating methods for monitoring population trends, and modeling biological data. I am senior author of a book that outlines and describes how to design and conduct monitoring programs for detecting significant trends in fish and wildlife populations over space and time. My knowledge of the latest techniques for modeling biological data was primarily obtained via a class in AIC model selection co-taught by Drs. David Anderson and Kenneth Burnham, who have recently written a book on this subject. My combination of applied field experience, statistical consulting background, and quantitative training (49 credits of statistics courses) has allowed me to recognize the balance between the desire for scientific rigor and the reality of collecting field data. I have always sought to bridge the gap between statisticians and field biologists so that the best science possible can be produced in ecological studies.

PUBLICATIONS

Thompson, W. L., G. C. White, and C. Gowan. In Press. Monitoring vertebrate populations. Academic Press, San Diego, CA. (Book)
Thompson, W. L., R. H. Yahner, and G. L. Storm. 1990. Winter use and habitat characteristics of vulture communal roosts. Journal of Wildlife Management 54:77-83.

Yahner, R. H., G. L. Storm, and W. L. Thompson. 1990. Winter diets of vultures in Pennsylvania and Maryland. Wilson Bulletin 102:320-325.

Section 10. Information/technology transfer

Technology transfer beyond normal publication of scientific articles is an integral part of the overall research effort. Numerous presentations and workshops have been presented to ensure widespread distribution of all research products and allow feedback from users. Similar efforts in the future are anticiated. The BayVAM models and monitoring protocols developed in this effort are expected to be widely used by the Forest Service and other land-mangement agencies. Software and accompanying documentation developed in this effort will be made readily available via an internet website.